U.S. Department of Agriculture, Agricultural Research Service

Systematic Mycology and Microbiology Laboratory - Nomenclature Fact Sheets

October 15, 2011

Monilinia fructigena and related brown fruit rots

Monilinia fructigena is one of four related fungi that infect members of the Rosaceae, causing brown fruit rots of considerable economic importance. There has been some taxonomic confusion between the four species:*Monilinia fructigena, Monilinia fructicola, Monilinia laxa*, and *Monilia polystroma* Leeuwen 2002 (described based solely on anamorph). *Monilinia fructigena* is widespread in Europe, rarely infects blossoms and twigs, and occurs primarily on apples (*Malus* spp.), pears (*Pyrus* spp.), and other pome fruit trees, although it is also found on *Prunus* spp. The brown fruit rot of Japan, previously considered to be *M. fructigena*, is a distinct species based on recent morphological and molecular studies, and has been named *Monilia polystroma* Leeuwen 2002. *M. fructicola* is widespread in North America, commonly infects blossoms and twigs in addition to fruits, and occurs primarily on *Prunus* spp., but also on apples, pears, and other pome fruits in the Rosaceae. *M. laxa* co-occurs with the other brown rot fungi, primarily in Europe and the Pacific Northwest of North America. *M. laxa* resembles *M. fructicola* in infecting blossoms and twigs in addition to fruits, but has a host range more similar to *M. fructigena,* occurring more frequently on *Prunus* spp. but also on other members of the Rosaceae (see Batra 1991 for more details).

Geographic Distribution: North and South American Reports of *M. fructigena*

Although *M. fructigena* has been reported primarily from Europe and Asia (China, Korea), it was reliably identified by Batra (1979) in a single collection from Maryland. It was also reported as occurring in Cuba (Arnold 1986). In addition to *M. fructicola, Sclerotinia fructigena* (Pers.) Schröt. (=*M. fructigena*) was listed as occurring in Florida (Alfieri 1984). This name has an illegitimate later homonym *Sclerotinia fructigena* Norton 1902 = *M. fructicola* (see nomenclature below), therefore the report is questionable. Only *M. fructicola* was reported in a subsequent edition of the Florida host index (Alfieri 1994). The European and Mediterranean Plant Protection Organization (EPPO 2004) and CMI maps (CMI 1956, 1976, under the name *Sclerotinia fructigena*) list *M. fructigena* as absent but formerly present in Brazil, Chile, and Uruguay, a geographic distribution also reported by Batra (1991). Reports of *Monilia fructigena* in Brazil (Grillo 1936) may refer to *M. fructicola*. While Grillo's index was published after *M. fructicola* was described, the sources were pre-1928 (see nomenclature section below). Reports of *M. fructigena* in Chile may refer to *M. laxa*. While the CMI 1976 map reports *Sclerotinia fructigena* in Chile, the cited index (Mujica 1960, 1967) reports only *Monilinia laxa* (possibly a result of confusion surrounding the synonym *Sclerotinia cinerea* and its homonyms, see nomenclature section below).

In the SBML specimen database, numerous reports of *M. fructigena* in the United States previous to 1928 presumably refer to *M. fructicola* (see nomenclature section below). There are several reports of *M. fructigena* in the USA in the years 1928 through 1931, possibly also referring to *M. fructicola*. *M. fructigena* has been intercepted at ports of entry in Puerto Rico and throughout the USA (NY, PA, CA), mostly on fruits imported from Europe.

There are no reports in SBML databases of the occurrence of *M. fructigena* in Venezuela, and it was not listed in recent fungus host indices from Venezuela (Iturriaga 2000, Urtiaga 1986, 2004a, 2004b). *M. fructicola* has also not been reported as occurring in Venezuela in SBML databases or in recent fungus host indices (Iturriaga 2000, Urtiaga 1986, 2004a, 2004b), however *M. fructicola* is listed as present in Venezuela on the CABI Crop Protection Compendium website (EPPO 2004).

The nomenclature of the brown fruit rots of Rosaceae has been controversial, partly due to taxonomic confusion, and partly as a consequence of several key changes in the Code of Botanical Nomenclature affecting the priority and author citations of accepted names and synonyms. A brief review of the pertinent provisions may help to clarify the discussion of the nomenclatural history of these *Monilinia* spp. Under the current code (Greuter et al., 2000), Article 13 (d) specifies the starting point (date at which valid publication begins) as 1 May 1753. In an earlier version of the Code (Stockholm 1950), the starting point was designated as 1 Jan. 1821 for these fungi. For fungi initially described before 1821 (e.g., *Monilia fructigena*), as a consequence of the 1821 starting point, the synonymy was complex and difficult to document with any certainty, as discussed by Korf & Kohn (1979). Because we are now operating under a 1753 starting point (the new code supercedes all previous codes, Principle VI), we must revise the synonymy to include names published before 1821 and trace priority of names back to these earlier dates.

Another source of nomenclatural confusion for *Monilinia* spp. has been the issue of names in teleomorph genera based on description of the anamorph only. There are several articles of the current code that relate to this issue. Article 59 states that only the teleomorph can provide the name of the holomorph (the species in all its morphs) (59.1). The protologue must include a description or diagnosis of the teleomorph, or the name is treated as an anamorph name (59.2). Anamorph names (even when assigned to a holomorph genus) can only apply to the anamorph, and cannot serve as the basis for a new name or new combination for the teleomorph or holomorph (59.6). Anamorph and holomorph names are to be treated as two distinct names (Art. 34.2 note 1): "They have different types, and the circumscription of the holomorph is considered to include the anamorph, but not vice versa."

Application of these provisions can lead to some difficulties. A common situation is the transfer of an anamorph to a holomorph genus without a description of the teleomorph, as occurred with the transfer of *Monilia fructigena* Pers.:Fr. 1801 (anamorph) to the holomorph genus *Sclerotinia* by J. Schröt. in 1893. Later authors attempted to add the teleomorph description to the name, but because the current code treats this as a description of a distinct fungus (i.e., a new species), the result was to create several illegitimate later homonyms for the name *Sclerotinia fructigena*. In addition, subsequent authors often publish new holomorph names attributing the basionym to authors of anamorph names or to authors of names now considered to be illegitimate later homonyms (e.g., *Monilinia fructigena* Honey ex Whetzel 1946, as *M. fructigena* (Aderh. & Ruhland) Honey, based on an illegitimate later homonym). This is considered a correctible error (Art. 58, Art. 59.6) and has led to many changes in author citations (and priority) in the nomenclature records for *Monilinia* spp.

Monilinia fructigena Honey ex Whetzel 1945 (Ascomycetes, Helotiales)

[≡Sclerotinia fructigena Aderh. & Ruhland 1905 - illegitimate later homonym, not included in search] Note: Not (Pers.:Fr.) Schröt. 1893; Aderhold & Ruhland were the first to describe the teleomorph but under name already in use for the anamorph (Art. 59.5 note 1, 51.1, 53, 34.2 note 1).

[Sclerotinia fructigena Aderh. ex Sacc. 1906]

Alternate State (Anamorph): Monilia fructigena Pers. : Fr.

Distribution: Europe, Asia (Japan, China). Also reported in South America (Brazil, Uruguay), North America (MD). Reports in North America may be *Monilinia fructicola* (G. Winter) Honey 1928.

Substrate: Primarily fruits, rarely blossoms and twigs.

Disease Note: Brown fruit rot. Overwinters in mummified fruits.

Host: *Malus* spp., *Pyrus* spp., *Prunus* spp. and other Rosaceae, also reported on *Vitis vinifera* (Vitaceae).

Internal Note: Honey used the combination in 1936 (Am. J. Bot. vol 23 p. 105) but with no description nor reference to basionym. Whetzel cited Honey as author, but he was the first to use the combination with reference to basionym %Sclerotinia fructigena% Aderh. & Ruhl. 1905 (illeg. later hom. of S. fructigena (Pers.:Pers) Schröt. based on anamorph description only). See Art. 41.3, 51.1, 53, 58, 59.5 note 1.

Verified By: Erica On Jun 06, 2005

Monilia fructigena Pers. : Fr. 1801

≡Oospora fructigena (Pers. : Fr.) Wallr. 1833

≡Sclerotinia fructigena (Pers. : Fr.) J. Schröt. 1893 Note: Listed by Batra 1991 as nom. nud. but described by Kohn 1979 as containing description of anamorph, therefore valid name for anamorph (Art. 51.1). Could not locate protologue to confirm.

≡Acrosporium fructigenum (Pers.) Pers. 1822 Note: Checked protologue.

= Oospora candida Wallr. 1833

[≡Stromatinia fructigena (Pers. : Fr.) Boud. 1907 - illegitimate later homonym, not included in search] Note: Not Ritz. Bos 1904.

= Torula fructigena Pers. 1796 Note: Description insufficient to distinguish from other brown rot fungi (Harrison 1933; from CPC website).

= Oidium fructigenum Kunze & J.C. Schmidt 1817 Note: Name changed from Link. Later homonyms (not in DB): Link (?), Schmidt 1819, Fries 1832, Thüm. 1879.

= Oidium wallrothii Thüm. 1875 Note: Could not locate protologue to confirm.

Alternate State (Teleomorph): Monilinia fructigena Honey ex Whetzel

Notes: American literature references to *Monilia fructigena* previous to 1928 probably refer to *Monilia fructicola* Batra 1991.

Distribution: Europe, Asia (China), South America (Uruguay, Brazil). Reports in North America may refer to *Monilia fructicola* Batra 1991. Reports in Japan probably refer to *Monilia polystroma* Leeuwen 2002.

Substrate: Primarily fruits, rarely blossoms and twigs.

Disease Note: Brown rot. Overwinters in mummified fruits.

Host: *Malus* spp., *Pyrus* spp., *Prunus* spp. and other Rosaceae, also reported on *Vitis vinifera* (Vitaceae).

Supporting Literature:

Batra, L.R. 1991. World species of ***Monilinia*** (Fungi): Their ecology, biosystematics and control. Mycol. Mem. 16: 1-246.

Honey, E.e. 1936. North American species of ***Monilinia***. I. Occurrence, grouping, and life-histories. Amer. J. Bot. 23: 100-106.

Kohn, L.M. 1979. A monographic revision of the genus ***Sclerotinia***. Mycotaxon 9: 365-444.

Korf, R.P., and Kohn, L.M. 1979. Later starting point blues. I. ***Monilia fructigena***. Mycotaxon 9: 521-522.

Whetzel, H.H. 1945. A synopsis of the genera and species of the Sclerotiniaceae, a family of stromatic inoperculate Discomycetes. Mycologia 37: 648-714.

Verified By: Erica On Jun 08, 2005

The earliest potential description of the anamorph (conidial state) of this fungus was made by Persoon in 1796, under the name *Torula fructigena*. Harrison (1933) found Persoon's 1796 description insufficient to distinguish among the other *Monilinia* spp. on Rosaceae (Batra 1991). In 1801 Persoon described the conidial state of the fungus as *Monilia fructigena* (subsequently sanctioned by Fries), later transferring it to the genus *Acrosporium* as *Acrosporium fructigenum* (Pers.) Pers. 1822. Wallroth placed it in the genus *Oospora* as *Oospora fructigena* (Pers.:Fr.) Wallr. 1833. Boudier transferred it into the genus *Stromatinia* as *Stromatinia fructigena* (Pers.:Fr.) Boud. 1907, thereby creating an illegitimate later homonym of *Stromatinia fructigena* Ritz. Bos 1904 (=*Monilinia fructicola* (G. Winter) Honey 1928). In addition, *Oospora candida* Wallr. 1833, *Oidium fructigenum* Kunze & J.C. Schmidt 1817, and *Oidium wallrothii* Thüm. 1875 are considered to be taxonomic synonyms (Batra 1991).

In 1893, Schröter transferred Persoon's anamorphic fungus to the holomorph genus *Sclerotinia*, without a description of the teleomorph state, creating the anamorph name *Sclerotinia fructigena* (Pers.:Fr.) J. Schröt. 1893. Aderhold & Ruhland (1905) added a description of the teleomorph to the name, thereby creating an illegitimate later homonym, *Sclerotinia fructigena* Aderh. & Ruhland 1905 (often cited as (Pers.) Aderh. & Ruhland 1905).

In 1936, Honey used the combination *Monilinia fructigena*, without description or reference to a description (invalid name, violating Art. 41.3). In 1946, Whetzel was the first to validly publish the combination, cited as *Monilinia fructigena* (Aderh. & Ruhland) Honey 1936, with reference to the description of the teleomorph provided by Aderhold & Ruhland for *Sclerotinia fructigena* Aderh. & Ruhland 1905. Because *S. fructigena* Aderh. & Ruhland 1905 is an illegitimate later homonym of *S. fructigena* (Pers.:Pers) Schröt. 1893, the combination is properly cited as *Monilinia fructigena* Honey ex Whetzel 1946 (see Art. 58). This is the currently accepted holomorph name for this taxon.

Monilinia fructicola (G. Winter) Honey 1928 (Ascomycetes, Helotiales)

≡ Ciboria fructicola G. Winter 1883

≡Sclerotinia fructicola (G. Winter) Rehm 1906

= Sclerotinia americana Norton & Ezekiel 1924 Note: Based on Sclerotinia cinerea forma americana Wormald 1919 (anamorph).

= Stromatinia fructigena Ritz. Bos 1904 Note: Not (Pers.:Fr.) Boud. 1907

[≡ Sclerotinia fructigena Norton 1902 - illegitimate later homonym, not included in search] Note: Not (Pers.:Fr.) Schröt. 1893.

Alternate State (Anamorph): Monilia fructicola Batra

Notes: =pro parte: *Sclerotinia cinerea* Matheny 1913 and *Sclerotinia cinerea* (Bonord.) Schröt. ex Aderh. & Ruhland 1905, illeg. later homonyms, not *Sclerotinia cinerea* (Bonord.) Schröt. 1893.

Distribution: Widespread.

Substrate: Blossoms, twigs, fruits.

Disease Note: Brown fruit rot, wilt, blight, canker.

Host: Rosaceae, primarily *Prunus* spp., also Pomoideae including apple (*Malus*) and pear (*Pyrus*). Reported on *Vitis vinifera* (Vitaceae).

Verified By: Erica On Jun 06, 2005

Monilia fructicola Batra 1991

= Monilia cinerea f. americana Wormald 1919

Alternate State (Teleomorph): Monilinia fructicola (G. Winter) Honey

Notes: Names of *Monilia fructigena* and its synonyms have sometimes been misapplied to this fungus. See Batra 1991.

Distribution: Widespread.

Substrate: Blossoms, twigs, fruits.

Disease Note: Brown fruit rot, wilt, blight, canker. Overwinters in mummified fruits.

Host: Rosaceae, primarily *Prunus* spp., also Pomoideae including apple (*Malus*) and pear (*Pyrus*). Reported on *Vitis vinifera* (Vitaceae).

Supporting Literature:

Batra, L.R. 1991. World species of ***Monilinia*** (Fungi): Their ecology, biosystematics and control. Mycol. Mem. 16: 1-246.

Kohn, L.M. 1979. A monographic revision of the genus ***Sclerotinia***. Mycotaxon 9: 365-444.

Verified By: Erica On Jun 06, 2005

The teleomorph of this fungus was first described on mummified peaches from Pennsylvania as *Ciboria fructicola* G. Winter 1883 (Batra 1991). It was transferred to the genus *Sclerotinia* by Rehm (*Sclerotinia fructicola* (G. Winter) Rehm 1906) and to *Monilinia* by Honey (*Monilinia fructicola* (G. Winter) Honey 1928), the currently accepted name. *Sclerotinia americana* Norton & Ezekiel 1924 is a taxonomic synonym (Batra 1991).

In 1902, Norton observed the teleomorphic state of a *Monilia* sp. on *Prunus* fruits from Maryland and named it *Sclerotinia fructigena* Norton 1902, creating an illegitimate later homonym of *Sclerotinia fructigena* (Pers.:Fr.) J. Schröt. 1893 (anamorph of *Monilinia fructigena*). The existence of this homonym may have added to the confusion between *Monilinia fructigena* and *Monilinia fructicola* in the host and geographic distribution literature.

Before the American brown fruit rot was described as *Monilinia fructicola* (G. Winter) Honey 1928, American collections were frequently reported under the name *Monilia fructigena*. After 1928, the invalid name *Monilia fructicola* was used, despite the lack of a formal description of the anamorph (Batra 1991). In 1991 Batra provided a description of the anamorph, *Monilia fructicola* Batra 1991, the currently accepted name.

Further confusion was caused by the partial synonyms (syn. pro parte) *Sclerotinia cinerea* Matheny 1913 and *Sclerotinia cinerea* (Bonord.) Schröt. ex Aderh. & Ruhland 1905, illegitimate later homonyms of *Sclerotinia cinerea* (Bonord.) Schröt. 1893 = *Monilinia laxa* (Aderh. & Ruhland) Honey 1945.

Monilinia laxa (Aderh. & Ruhland) Honey 1945 (Ascomycetes, Helotiales)

≡ Sclerotinia laxa Aderh. & Ruhland 1905

≡Stromatinia laxa (Aderh. & Ruhland) Chifflot 1921

[= Sclerotinia cinerea Wormald 1921 - illegitimate later homonym, not included in search]

[Stromatinia laxa (Aderh. & Ruhland) Naumov 1964]

Alternate State (Anamorph): Monilia laxa (Ehrenb.) Sacc. & Voglino

Notes: =*Sclerotinia cinerea* Matheny 1913 pro parte.

Distribution: North America (Pacific Northwest), South America, Europe, Asia, Australia, Africa (South Africa).

Substrate: Blossoms, shoots, twigs, fruits.

Disease Note: Wilt, blight, canker, brown fruit rot. Overwinters in mummified fruits.

Host: Rosaceae, primarily *Prunus* spp., also apples (*Malus* spp.), pears (*Pyrus* spp.) and other Pomoideae.

Verified By: Erica On Jun 06, 2005

Monilia laxa (Ehrenb.) Sacc. & Voglino 1886

≡ Oidium laxum Ehrenb. 1818 Note: Not Duby 1830. Previously considered to be invalid due to later starting point in earlier codes. (checked protologue in rare books).

≡Oospora laxa (Ehrenb.) Wallr. 1833

≡Acrosporium laxum (Ehrenb.) Pers. 1822

= Sclerotinia cerasi Woronin 1895

≡ Stromatinia cerasi (Woronin) Boud. 1907

= Monilia cinerea Bonord. 1851 Note: Not Sacc. & Vogl. 1886 nor Woronin 1900

≡ Sclerotinia cinerea (Bonord.) J. Schröt. 1893 Note: Description of anamorph but placed in teleomorph genus (Art. 51.1).

[Monilia laxa (Wallr.) Sacc. & Voglino 1886] Note: Author citation used during period when Oidium laxum Ehrenb. 1818 was considered to be invalid due to starting point in previous codes.

= Monilia oregonensis Barss 1923

Alternate State (Teleomorph): Monilinia laxa (Aderh. & Ruhland) Honey

Distribution: North America (Pacific Northwest), South America, Europe, Asia, Australia, Africa (South Africa).

Substrate: Blossoms, shoots, twigs, fruits.

Disease Note: Wilt, blight, canker, brown fruit rot. Overwinters in mummified fruits.

Host: Rosaceae, primarily *Prunus* spp., also apples (*Malus* spp.), pears (*Pyrus* spp.) and other Pomoideae.

Supporting Literature:

Batra, L.R. 1991. World species of ***Monilinia*** (Fungi): Their ecology, biosystematics and control. Mycol. Mem. 16: 1-246.

Verified By: Erica On Jun 06, 2005

The teleomorph of this fungus was first described as *Sclerotinia laxa* by Aderhold & Ruhland in 1905. Chifflot transferred it to *Stromatinia* (*Stromatinia laxa* (Aderh. & Ruhland) Chifflot 1921). Honey transferred it to *Monilinia* as *Monilinia laxa* (Aderh. & Ruhland) Honey 1945, the currently accepted name.

The nomenclature of the anamorphic state remains controversial (Batra 1991). Ehrenberg's description of *Oidium laxum* Ehrenb. 1818 serves as the basionym for the currently accepted name. It is possible, however, that Persoon's descriptions of *Torula fructigena* Pers. 1796, *Monilia fructigena* Pers.:Fr. 1801 and *Acrosporium fructigenum* (Pers.:Fr.) Pers. 1822 refer to the fungus currently named *Monilia laxa* rather than to *Monilia fructigena* (Batra 1991). If this were accepted to be the case, in the genus *Monilia* the epithet *fructigena* (1796) would have priority over *laxum* (1818) for this fungus. The brown fruit rot currently known as *Monilia fructigena* would also need to be renamed. Because no type specimen is available for Persoon's fungus, it has been difficult to settle this issue. At this point, *M. laxa* is the currently accepted name for the conidial state of this fungus (Batra 1991).

Additional references:

Alfieri Jr., S.A., Langdon, K.R., Kimbrough, J.W., El-Gholl, N.E., and Wehburg, C. 1994. Diseases and Disorders of Plants in Florida. Florida Dept. Agric. and Consumer Serv., Div. Plant Ind. Bull. 14 : 1114

Arnold, G.R.W. 1986. Lista de Hongos Fitopatogenos de Cuba. Ministerio de Cultura Editorial Cientifico-Tecnica, 207 pages.

Batra, L.R. 1979. First authenticated North American record of *Monilinia fructigena*, with notes on related species. Mycotaxon 8 : 476-484

C.M.I. 1956. *Sclerotinia fructigena*. C.M.I. Map 22 ed. 2: 1-2

C.M.I. 1976. *Sclerotinia fructigena*. C.M.I. Map 22 ed. 4 : 1-2

EPPO, 2004. PQR database (version 4.3). Paris, France: European and Mediterranean Plant Protection Organization.

Grillo, H.V.S. 1936. Lista preliminar dos fungos assignalados em plantas do Brasil. Ann. Prim. Reun. Phytopathol. Brasil 2 : 39-96

Greuter, W., and et al., Eds. 2000. International Code of Botanical Nomenclature (Saint Louis Code). Koeltz Scientific Books, 474 pages.

Iturriaga, T., P@aez, I., Sanabria, N., Holmquist, O., Bracamonte, L., and Urbina, H. 2000. Present state of knowledge of Venezuelan mycobiota. Ministerio del Ambiente y de los Recursos Naturales Renovables (MARNR) : 147 pages.

Koch de Brotos, L. & Boasso, C. 1955. Lista de las enfermedades de los vegetales en el Uruguay. Rep. Uruguay, Min. Gan. Agr., Lab. Fisiologia y Patologia Vegetal #106, Montevideo.

Mujica, F., and Vergara, C. 1961. Addenda a Flora Fungosa Chilena (I). Imprenta Stanley, page 22.

Mujica, F., and Oehrens, B.E. 1967. Segunda addenda a flora fungosa Chilena. Boletin Tecnico 27 : 1-78

Urtiaga, R. 1986. Indice de enfermedades en plantas de Venezuela y Cuba. 202 pages.

Urtiaga, R. 2004a. Indice de enfermedades en plantas de Venezuela y Cuba, Second Edition. 301 pages.

Urtiaga, R. 2004b. Host index of plant diseases and disorders from Venezuela - Addendum: 268 pages.

****

Written by Erica Cline, December 2005